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ERADICATION OF TUBERCULOSIS IN CATTLE*

IN the course of the last half-century, much has been written on the danger to the human population of the existence of tuberculosis in cattle. There have been strong demands for the elimination of the disease from cattle in Britain, and inevitably opposition to this policy has been roused, on the ground of the magnitude of the task from the economic aspect; the danger of damaging the milk supply of the nation because of the large proportion of milch cows that are tuberculous; the desirability of maintaining infection with tuberculosis in order that the milk of the nation may be infected, so that those consuming it may acquire immunity and withstand the ordinary risks of infection from contact with people suffering from the disease; from a belief that pasteurization destroys a food factor not easily replaceable, and essential for those who depend largely or entirely on a milk diet; and by some because of a mystical belief that animals should be maintained according to what are spoken of vaguely as "natural" methods.

A great deal of factual information is now available, and experience in other countries strengthens the case of those who favour action to remove a serious source of ill-health in the most important class of livestock in Britain. To-day it can be asserted with confidence that the important agricultural interests are to the fore in the demand for means to get rid of the disease. On many of the questions which were controversial only a few years ago, there is now general agreement.

The history of efforts to control the disease in cattle in all countries is that individual voluntary effort fails to yield results of any considerable value. To attain results which are worth while, operations have to be carried out through the agency of well-organised government departments, supported by certain powers conferred by legislative action, with the co-operation of the industries concerned and under conditions that enable financial aid on a suitable scale to be given to compensate for the special measures required from the owner, until success has been achieved. A primary factor in the

* Reproduced from *Nature*, Vol. 158, 311-12, 1946.

organisation for ridding cattle of the disease is the possession of a sufficiently reliable and convenient means of detecting the affected animals. This is provided by the tuberculin test. There are, however, differences of opinion about the most suitable type of tuberculin and the manner in which it should be used.

In the United States of America, an intense nation-wide campaign was carried out by combined Federal and State veterinary departments from 1917, when it was considered that 6-8 per cent. of all American cattle were infected, until 1940, when in every county of every State less than one half of one per cent. of the cattle were reactors to the tuberculin test and, incidentally, not more than one half of those reactors in 1940 were actually affected with tuberculosis. The tuberculin used in this campaign was prepared from a culture of tubercle bacilli grown on a special nutrient medium consisting entirely of known chemical products and free from proteins. The resultant growth was then concentrated by heating. A more refined type of tuberculin is now available. It is grown similarly on a defined chemical, protein-free culture medium, but it is concentrated chemically, to separate the tuberculin protein, known as 'purified protein derivative' (P. P. D.), from the other constituents of the final growth. The tuberculin prepared officially for use on animals in Great Britain is P. P. D.

There are different ways of using tuberculin. The intradermal test is conceded to be eminently satisfactory in cattle. In the United States, a dose of tuberculin is injected intradermally into a subcaudal fold; there are two natural folds of skin in cattle at the ventral surface of the root of the tail, and the uninjected fold serves as a control. In Great Britain a 'double intradermal' test has been used for the last twenty years or so. A dose of tuberculin is injected into the same site.

At the recent congress of the Royal Sanitary Institute at Blackpool, at a meeting of the Section of Veterinary Hygiene, Mr. John Francis, of Imperial Chemical Industries, Ltd. (Biological Laboratories), discussed the tuberculin test in detail and also the control of tuberculosis in cattle, with special reference to conditions in Great Britain.

Prof. T. Dalling, director of the Veterinary Laboratory, Ministry of Agriculture, described work on the disease in progress in Great Britain. He emphasized that, in addition to the great danger to human beings from tuberculosis in cattle, the economic loss sustained by the farming industry and by the State, on account of the extent of the disease in our cattle, is also very important. There is clear evidence that herds free from the disease have a very much higher standard of health than infected herds. When young stock in affected herds are kept apart from the adult cattle, and are not given infected milk, the tuberculosis-rate in them is low. Incidentally, cattle can acquire the disease from contact with infected human beings.

Tests of the usefulness of the vaccination of cattle against the disease have been in progress for some years. Results of some value have been obtained, and it is possible that in certain circumstances vaccination may play a part in control operations. For some years farmers have been encouraged to eliminate the disease through the Government Attested Herd and Tuberculin Tested Herd schemes, and a good deal of progress has been made, in that a large number of herds are now so dealt with.

Prof. Dalling explained that investigations of the value of the different types of intradermal tuberculin tests are in progress, and that if a simpler test than the one hitherto used in Great Britain is found to be satisfactory, it will be given consideration by those responsible for policy.

The following resolution was passed at the meeting: "That this section is of the opinion that the Government, in its post-war plans for increasing the efficiency of agriculture and so improving public health, should give high priority to the eradication of bovine tuberculosis."

Closely bound up with the tuberculosis problem, but concerned also with other diseases that affect mankind, is the general question of a safe milk supply. Recent developments are discussed in an article in the **Lancet*. Among the matters referred to are the pasteurization controversy; the monetary value of the losses due to tuberculosis in cattle (£20-£30 million a year); the marketing of cattle that are reactors to the tuberculin test; the inoculation of calves against bovine brucellosis (contagious abortion); financial assistance required by farmers to help them to free their herds from tuberculosis; the provision of a free State veterinary service; the establishment of a system of eradicating tuberculosis by producing disease-free areas, which would be gradually extended; the provision of a State abattoir service under veterinary supervision, to ensure that the meat supply is sound and, incidentally, to serve as a guide to the incidence of the important diseases of cattle; the need for adequate water supplies on farms and, on a great many farms, for improved buildings.

The article deals with many aspects of the subject and shows in what directions developments are required; and it is to be hoped that, before long, it will be possible to embark on a new stage of the campaign against disease in dairy cattle. What many would like to see would be the first stages of an 'area plan.'

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*2nd March, 1946.

MOSAIC DISEASES OF MALVACEAE IN TRINIDAD, B.W.I.*

BY

HAROLD OWEN

Introduction

For some years, variegations suggestive of a virus causation have been observed on certain Trinidad plants belonging to the Malvaceae, and on one member of the Tiliaceae. The present investigation was designed to survey this group of diseases and to study their inter-relationships. One of the plants concerned, okra (*Hibiscus esculentus*), is of economic importance as a food crop. The major object was to attempt transmission of the casual agents of the diseases between as many species as practicable in the time available. A mosaic of *Triumfetta lappula* (Tiliaceae) was included in the investigation, since the symptoms are similar to those of the malvaceous mosaics, and the Tiliaceae and Malvaceae are closely related.

Literature

The variegation of species of *Abutilon* has long been known; Lemoine (1869) made the first observation on the transfer of the variegation to other *Abutilon* species by grafting, and Lindemuth (1907) accomplished transmission to a number of Malvaceae. The causal agent was classified as *Abutilon* Virus 1 by Smith (1937).

Pickles & Thorold (1929) first recorded a mosaic disease of Malvaceae in Trinidad, noting a mosaic on *Sida* sp. Dale (1943), in Trinidad, records mosaics on *Sida* spp., *Hibiscus esculentus, Malachra alceifolia* and *Triumfetta* sp. He was unable to transmit the mosaic virus by mechanical inoculation from *Sida acuta* to *S. acuta, Hibiscus esculentus, Gossypium barbadense* or *G. hirsutum*. The same worker (personal communication) found similar symptoms on *Sida* spp. throughout the Windward Islands, and on *Triumfetta lappula* in Grenada, B.W.I. Mosaics of *Sida* spp. are recorded from Puerto Rico (Cook, 1931), Florida and Haiti (Kunkel, 1930), Jamaica (Simmonds, personal communication), Brazil (Silberschmidt, 1943) and Sierra Leone (Deighton, 1936). Park (1929) records a mosaic of *Hibiscus esculentus* from Ceylon. A mosaic of the same species is stated by Uppal *et al.* (1941) to be widespread in the Poona district of India, where it seriously affects fruit production. The virus is neither sap- nor seed-transmissible, but was transmitted by grafting and by the white-fly *Bemisia gossypiperda* M. & L. What appears to be the same disease of *H. esculentus* is present also in the Bombay district (Anon., 1942).

Silberschmidt (1943) worked in Brazil on mosaics of *Sida acuta, S. rhombifolia, S. glaziovii* (as *S. cordifolia*, corrected *in litt.* to Dale) and *Abutilon striatum*. He obtained no transmission by sap-inoculation or through the seed, but graft-transmission was obtained from *Sida acuta* and *S. rhombifolia* to *S. acuta* and *S. rhombifolia* in each case, and from *S. glaziovii* to *S. rhombifolia*. Silberschmidt states that stocks of *S. acuta* displayed more severe symptoms when infected from diseased scions of this species than if the virus were transmitted from scions of *S. rhombifolia*. Diseased scions of *Abutilon striatum* transmitted a virus producing 'normal' symptoms in stocks of *Sida rhombifolia*, while only very slight symptoms appeared in stocks of *S. acuta*. Transmission from mosaiced *S. rhombifolia* to healthy *A. striatum* occurred in only one case, out of seven grafts. Silberschmidt concludes that the viruses causing mosaic in the different species are identical, and attempts to explain the differences in degree of symptom expression in plants of *Sida acuta* infected from different sources by suggesting that the weaker forms of the mosaic may be caused by insufficient quantities of virus, by the lack of a second virus component necessary for the formation of a virus complex, by the lack of an 'activator' substance or of aggregated particles of the virus. Silberschmidt's work is open to criticism in that he used no controls in his experiments. The effect of this omission is discussed below. Orlando & Silberschmidt (1945) have shown that certain members of the Aleyrodidae (species not stated) can act as vectors of the virus causing mosaic in *Sida rhombifolia*.

Host Range

The following species have been seen by the writer with mosaic in Trinidad:

Hibiscus esculentus L.
Malachra alceifolia Jacq.
Sida acuta Burm.
S. glomerata Cav.
S. linifolia Juss.
S. rhombifolia L.
S. urens L.
Triumfetta lappula L. (Tiliaceae)

The list of Malvaceae below consists of species found by the writer, which he has not seen with mosaic:

Gossypium spp.
Hibiscus abelmoschus L.
H. rosa-sinensis L. and hybrids
H. sabdariffa L.
Malachra fasciata Jacq.
Malvastrum coromandelianum (L.) Garcke
Sida kohautiana Presl.
Urena lobata L.
Wissadula contracta (Link.) Fries.
W. periplocifolia (L.) Presl.

*The subject-matter of this paper forms part of a thesis submitted in partial fulfilment of the requirements for the Associateship of the Imperial College of Tropical Agriculture, Trinidad, B.W.I.

Symptoms

The expression of mosaic is somewhat different according to the species of host, and there is much variation within each species. To generalize : the symptoms are in all cases those of localised chlorosis of the leaves; in *Hibiscus esculentus* the chlorosis is interveinal without veinal chlorosis (vein-clearing); *Sida* spp. show interveinal chlorosis and a very limited amount of vein-clearing; in *Malachra alceifolia* and *Triumfetta lappula* conspicuous veinal chlorosis occurs together with interveinal chlorosis.

The colour of the chlorotic areas varies from pale green, through shades of yellow, to whitish. Degree of expression is influenced by light intensity and maturity of leaf, plants growing in full illumination generally showing brighter coloured mosaics than those in shade, and young leaves showing less prominent variegation than old.

An interesting feature, observed very frequently on all hosts, is the presence of healthy branches on diseased plants. This may indicate that the virus agents are not systemic. No experiments were made to confirm this. Davies (1929) and Keur (1934) refer to a similar phenomenon in *Abutilon* spp.

Hibiscus esculentus. Young leaves show interveinal blotches of all gradations of colour from just lighter than the normal green to yellow tinted with green. On older leaves the tendency in the most severe expression of the disease is for the entire leaf surface, except for the major veins, to be bright yellow or whitish, with the normal green colour of the leaf extending outwards from the veins in a narrow undulate band, locally absent. In severely mosaiced leaves there is often a slight blistering of the surface. In intermediate conditions of the mosaic, areas of the normal green colour are scattered over the leaf, bounded by veins, angular, and often sharply demarcated from bright yellow areas by veins of the second or even of the third order. Occasional mature or nearly mature leaves show only a diffuse yellow-green mottle.

Malachra alceifolia. Most young leaves show patches of a rather bright yellow colour, extending over and including the veins of the second and higher orders, and even sometimes of the first order. In some young leaves the veins alone are cleared. More mature leaves may show three types of mosaic: (1) a bright yellow or whitish vein-clearing extending to all orders of veins, the interveinal areas being of a normal green colour; (2) vein-clearing as (1), but with the interveinal areas showing some degree of chlorosis; (3) interveinal chlorosis without vein-clearing; this type is least common. The three types of symptom intergrade; all three may occur together on the same leaf, and they regularly occur together on a single plant; but as a rule one type of symptom predominates on any individual plant.

Sida spp. Apart from a very small amount of vein-clearing seen on a few young leaves of *Sida urens,* interveinal chlorosis is general. The symptoms are not much less conspicuous on young leaves than on mature ones and, though variable, are fairly constant for the leaves of any one plant. Areas bounded by the midrib, first order veins, and the margin may be entirely chlorotic or they may contain small green islands generally bounded by higher order veins. In other plants the leaves are dotted with quite small chlorotic areas, usually bounded by veins. A first order vein separating two adjacent chlorotic areas may or may not itself be chlorotic.

In general, it is not common for the entire interveinal surface of a leaf to be chlorotic; where this condition, or an approximation to it, does occur, it is normally shown only by a few of the older leaves, which are usually whitish. In *S. glomerata,* however, it is much more usual to find the entire leaf surface, or the greater part thereof, chlorotic, the condition usually being shown by all the mosaiced leaves of a plant.

There may be slight downward curling of the margins of the young leaves; this is especially common in *S. rhombifolia,* but is by no means general even in that species. In all species there is a tendency for severely mosaiced leaves to be malformed, giving a rugose effect, as in *Hibiscus esculentus.*

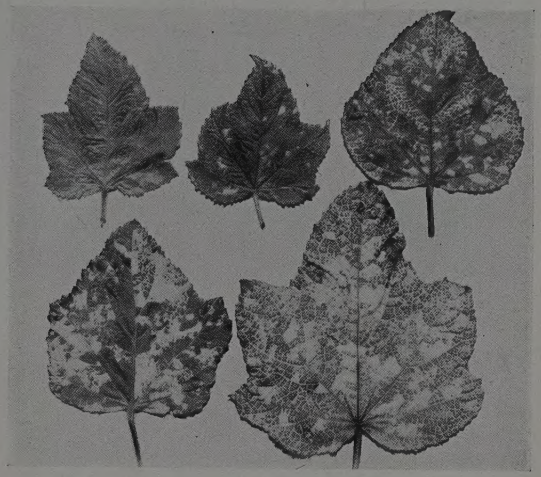
Triumfetta lappula. There are two main types of symptom in this species: conspicuous vein-clearing and very sharply defined interveinal chlorosis; the two frequently occur together on the same leaf. There may be some variation between individual leaves but any one plant shows a preponderance of one symptom or the other. The symptoms on the youngest leaves are inconspicuous. They consist of small blotches slightly paler than the normal green of the healthy leaf, and very inconspicuous veinal chlorosis, in varying proportions. As the leaves develop, the markings extend and become more sharply defined and brighter in colour. Veins up to the fourth order may be cleared (in veinal chlorosis), or delimit chlorotic areas (in interveinal chlorosis).

Transmission by Sap and Seed

No worker has transmitted the virus causing a mosaic in any species of Malvaceae by contact or inoculation with expressed sap. The writer was unable to transmit the virus causing mosaic in *Sida acuta* by sap-inoculation.

Large numbers of seedlings of *Hibiscus esculentus* and *Sida acuta* were raised from seed of healthy and mosaiced plants. None of the seedlings, removed at the three-leaf stage, exhibited mosaic. Seed from mosaiced plants of *S. acuta* showed a germination capacity significantly lower (at the 0.1% level) than that from healthy plants (12.4% and 25.3% respectively, after three months—1,000 seeds of each sown); this was not the case with *H. esculentus.*

A



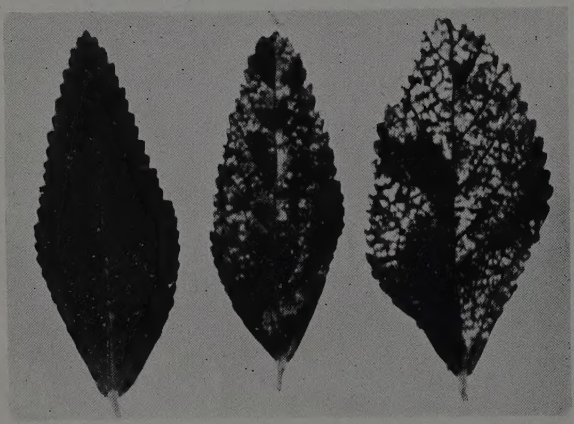
B

C

PLATE I.—Mosaic symptoms on A. *Hibiscus esculentus* ($\times \frac{1}{3}$); B. *Malachra alceifolia* ($\times \frac{1}{3}$); C. *Triumfetta lappula* ($\times \frac{3}{8}$). Healthy leaf at top left in A and B and on left in C.

A

B



C

D

PLATE 2.—Mosaic symptoms on A. *Sida acuta* ($\times 1\frac{1}{4}$); B. *Sida glomerata* ($\times \frac{7}{8}$); C. *Sida rhombifolia* ($\times 1\frac{1}{4}$); D. *Sida urens* ($\times \frac{3}{4}$). Healthy leaf on left in A, C, and D and at top left in B.

Transmission by Grafting

METHODS

The technique used was the 'bottle graft', which is an application of inarching, a cut shoot being used as the scion, with its lower end immersed in a vessel of water (Blakeslee & Farnham, 1923; Harland, 1927). The stocks were trimmed, the older leaves and some of the side shoots being removed. The scions were trimmed similarly, but more drastically, only one or two of the youngest leaves being left. A thin slice was taken out of the stem of the stock, and a similar one from the scion. The cut surfaces were placed together, the zone of union firmly bound round with thin cloth tape, and the end of the scion placed in a tube of water. Ten to fourteen days after grafting, the tapes and tubes of water were removed, and the lower part of the scion was cut off immediately below the zone of union. Experiments were terminated two months from the time of grafting. In almost every experiment twelve stocks were grafted with mosaiced scions and eight (controls) with healthy scions. Stocks and control scions were grown from seed.

RESULTS

Table 1 summarises the results of grafting experiments. The mosaic of each species found naturally infected (with the exception of *Sida linifolia*, which was not studied), has been shown to be caused by a virus, by transmission from mosaiced to healthy plants of the same species. Every combination of grafts between the three species *Sida acuta*, *S. rhombifolia* and *S. urens* was made. In every case symptoms were produced in some of the stocks grafted with mosaiced scions, and there was no constant difference between symptom expression in the various combinations. However, in grafts of *Sida acuta* on *S. glomerata*, and of *S. glomerata* on *S. acuta*, no transmission was effected. No grafts were made between *S. glomerata* and species of *Sida* other than *S. acuta*. There was no transmission in any intergeneric or inter-family grafts, although some of the grafts were very successful.

Mosaiced plants in the field often showed healthy branches. Similarly, a stock infected by grafting seldom showed the symptoms in all its parts, even after two months. The branch or branches showing symptoms were above and/or below the zone of graft union, and symptoms were not necessarily shown by all branches above and/or below, as the case might be.

In each experiment where transmission took place, the stocks which became infected developed symptoms at about the same time, except in a few experiments where one or two plants showed mosaic at a much later date than the rest. Occasional control plants developed mosaic; here, too, the apparent incubation period was usually outside the range of incubation periods for the great majority of plants grafted with mosaiced scions. It was therefore considered that the late infections of plants grafted with mosaiced scions were 'accidental', *i.e.* they did not result from a transmission of virus from the scion. The stocks and control scions were grown from seed. In the absence of seed transmission, the most feasible explanation of these anomalous appearances of symptoms would seem to be the activity of an insect vector or vectors.

Transmission by Insects

This aspect of the problem received little attention. The existence of a vector or vectors was postulated from field evidence, where mosaic infection of a crop of *Hibiscus esculentus* was observed to increase with the age of the crop, and from 'accidental' infections occurring in the greenhouse. The latter was by no means insect-proof; aphids, thrips and white-flies were very abundant, especially *Aphis gossypii* Glover; scale-insects and mealy-bugs were also present. Regular nicotine spraying reduced the numbers only to a point where excessive plant damage was avoided. It is somewhat surprising that more 'accidental' infections did not occur; even in *Sida urens*, the species most liable to 'accidental' infection, only about 5% of plants raised from seed ever contracted the disease in this way; the vector would seem to be an 'inefficient' one, or else uncommon. A small-scale experiment with *Aphis gossypii* gave no evidence that this species could act as a vector of the virus causing mosaic in *Sida acuta*. The report by Orlando & Silberschmidt (1945) that certain white-flies can transmit the mosaic virus of *S. rhombifolia* in Brazil was not received by the writer until the present investigation had terminated. The white-fly *Bemisia gossypiperda* has been shown to be the vector of the virus causing mosaic in *Hibiscus esculentus* in India (Uppal *et al.*, 1941; Anon., 1942). This species is not recorded from the New World (Smith, 1937).

Discussion and Conclusions

It is not possible to throw much light on the inter-relations of the viruses studied, since no case of transmission from one genus to another has been accomplished. At present the agents responsible for the mosaics of (1) *Hibiscus esculentus*, (2) *Malachra alceifolia*, (3) *Sida acuta*, *S. rhombifolia* and *S. urens*, and (4) *Triumfetta lappula* should be considered distinct viruses.

The mosaics of *Sida acuta*, *S. rhombifolia* and *S. urens* are concluded to be caused by a single virus, since transmission occurred in grafts in every direction between the three species, with no constant differences in symptom expression. The position of the virus in the case of *S. glomerata* remains undecided, owing to the incomplete evidence.

Some differences from the results of Silberschmidt (1943) may be noted. The symptoms he describes on *Sida* spp. in Brazil bear a close resemblance to those in Trinidad, but he records a yellow colouring of the veins occurring

Table I

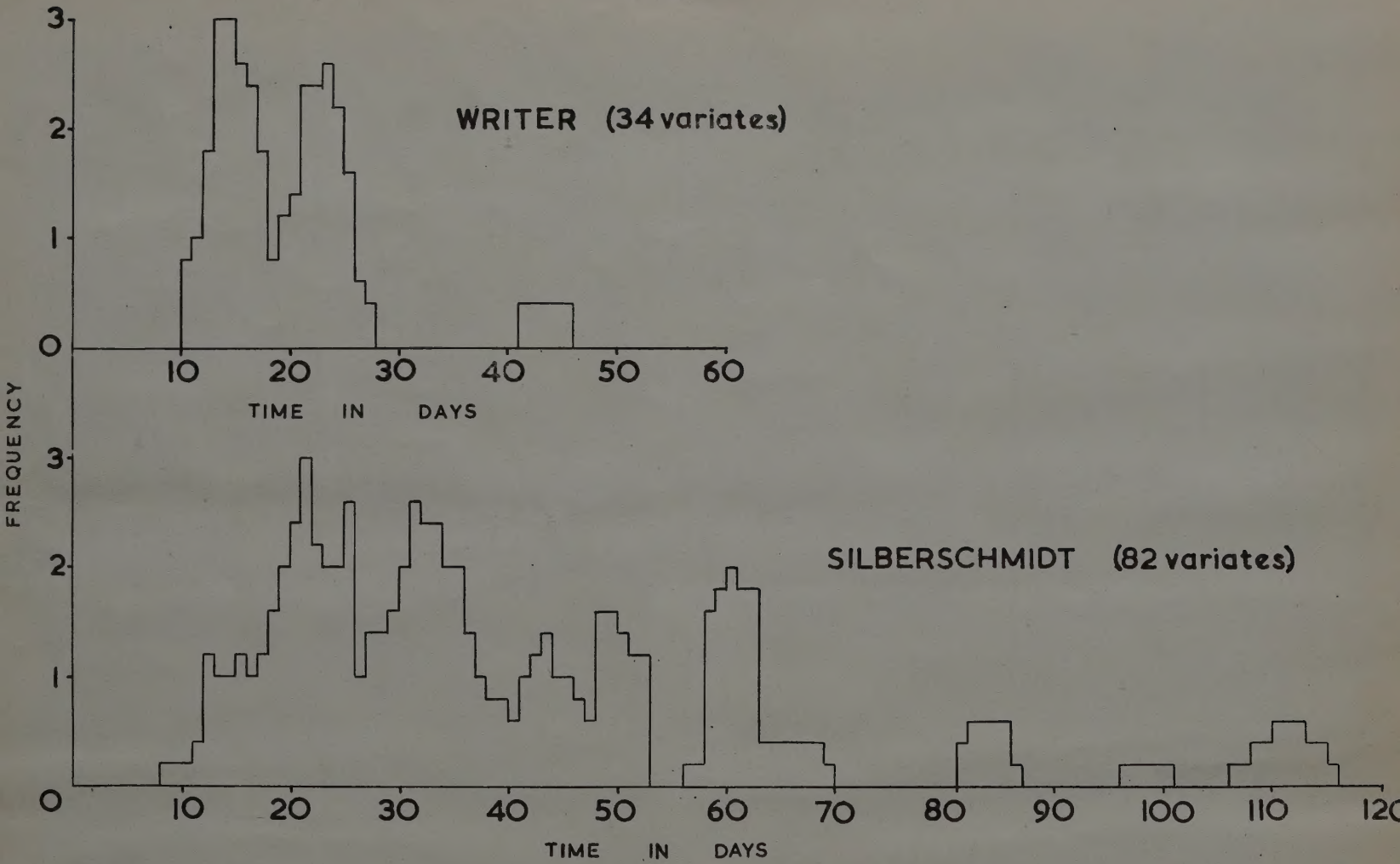
Results of Grafting Experiments

Stocks	Scions	Grafts with Mosaiced Scions†				Grafts with Healthy Scions			
		*Successful grafts	Number infected	Incubation period (days)		*Successful grafts	Number infected	Incubation period (days)	
				Range	Mean			Range	Mean
Gossypium barbadense ...	*Sida acuta*	0	—	—	—	0	—	—	—
Hibiscus abelmoschus ...	*Hibiscus esculentus* ...	12	0	—	—	8	0	—	—
Hibiscus esculentus	*Hibiscus esculentus* ...	16	2	26, 30	28.0	10	0	—	—
,, ,, ...	*Malachra alceifolia* ...	12	0	—	—	6	0	—	—
,, ,, ...	*Sida acuta*	0	—	—	—	0	—	—	—
Malachra alceifolia	*Hibiscus esculentus* ...	11	0	—	—	7	0	—	—
,, ,, ...	*Malachra alceifolia* ...	5	2	20, 29	24.5	7	0	—	—
,, ,, ...	*Triumfetta lappula* ...	11	0	—	—	7	0	—	—
Malvastrum coromandelianum ...	*Sida acuta*	10	0	—	—	8	0	—	—
Sida acuta	*Sida acuta*	11	9	15-25	19.7	8	0	—	—
,, ,, ...	*Sida glomerata*	6	0	—	—	6	0	—	—
,, ,, ...	*Sida rhombifolia* ...	12	6 (2)	14-19 (43, 43)	15.3 (22.3)	8	1	45	45.0
,, ,, ...	*Sida urens*	12	4	29, 29, 29, 29	29.0	8	0	—	—
Sida glomerata	*Sida acuta*	12	0	—	—	8	0	—	—
,, ,, ...	*Sida glomerata*	8	2	12, 12	12.0	4	0	—	—
Sida rhombifolia	*Sida acuta*	10	8	14-24	19.5	8	0	—	—
,, ,, ...	*Sida rhombifolia*	10	9	12-23	16.9	8	0	—	—
,, ,, ...	*Sida urens*	11	2	27, 38	32.5	8	0	—	—
Sida urens	*Sida acuta*	12	8 (1)	10-18 (36)	13.8 (16.2)	7	3	9, 19, 36	21.3
,, ,, ...	*Sida rhombifolia*	8	4 (2)	13-26 (43, 43)	21.3 (28.5)	5	1	17	17.0
,, ,, ...	*Sida urens*	12	8	11-26	14.9	5	2	8, 36	22.0
Triumfetta lappula	*Sida acuta*	10	0	—	—	8	0	—	—
,, ,, ...	*Triumfetta lappula* ...	8	2	24, 25	24.5	8	0	—	—
Urena lobata	*Sida acuta*	12	0	—	—	7	0	—	—
,, ,, ...	*Triumfetta lappula* ...	2	0	—	—	2	0	—	—

* 'Successful grafts' gives number of scions united, minus number of stocks died.

† Data relating to infections where symptoms appeared much later than majority are shown in brackets, and mean incubation period including these values is given in brackets.

FIG. 1



Histograms of frequency distribution of incubation periods for grafts involving *Sida acuta* and *S rhombifolia*, plotted as 5-day moving averages.

frequently as the first symptom. In Trinidad vein-clearing has been seen only in *S. urens*, and then very rarely. Silberschmidt states that *S. acuta, S. rhombifolia* and *S. glaziovii* are affected by mosaic to a different degree, *S. glaziovii* being least affected and *S. rhombifolia* most affected. In the present study no species has been found constantly or even generally to show more conspicuous symptoms than another.

Silberschmidt found that symptoms produced in healthy plants of *S. acuta* by virus transmitted from diseased plants of the same species were more severe than if the virus came from *S. rhombifolia*. In the writer's experiments there were no constant differences between symptoms produced in any series of unions between *S. acuta, S. rhombifolia* and *S. urens*.

In Table 2 the relevant incubation periods given by Silberschmidt are compared with those from the present investigation.

The upper limit of the range, and the mean, for each incubation period given by Silberschmidt is considerably higher than any shown in the writer's experiments. The latter were terminated after two months, so that no incubation period longer than about 60 days could be recorded. However, ignoring 'accidental' infections, an examination of Table 1 shows that in every case but one symptoms developed during the first 30 days, and there is not an unduly large scatter around the means. In Silberschmidt's results there is a very considerable scatter around each mean, and further, the mean is in every case nearer the lower limit of the range than the upper limit, *i.e.* the distribution is skew. It is suggested that this is due to a high incidence of 'accidental' infections, which would doubtless have been apparent had he employed controls.

Figure 1 shows the distribution of incubation periods in both series of experiments. Aside from the skew distribution of Silberschmidt's results, there is a discrepancy between the modal values from his experiments and the writer's. No explanation for this is apparent; it may be that the conditions are not strictly comparable, or a difference between the viruses concerned in the two countries may be indicated. The parallel bimodality of both curves is noteworthy. There are clearly some curious features of these infections which need explanation.

A limited amount of transmission of virus from *Sida* to *Abutilon* and *vice versa* was accomplished by Silberschmidt. It seems clear, from a comparison of plates and symptom descriptions, that he was dealing with plants infected with *Abutilon* Virus 1. No experiments have been performed in Trinidad with *Abutilon* spp., but considering the general similarity of the symptoms exhibited by *Sida* spp. in Trinidad and Brazil, it seems reasonable to suppose tentatively that *Abutilon* Virus 1 is responsible for the mosaics of *Sida* spp. in Trinidad.

It has not been possible to show whether the mosaic of okra (*Hibiscus esculentus*) can be carried from wild species of Malvaceae. It does not, however, appear that the mosaic of okra in Trinidad is of much economic importance. It was not possible to carry out experiments to determine the effect of virus infection on growth and yield, but observations on crops in all stages of growth indicate that the effect of mosaic is very slight. A characteristic of the mosaic of okra described from India (Uppal *et al.*, 1941; Anon., 1942) is that fruit production is seriously affected, while the symptoms are quite different from those in Trinidad, involving veinal chlorosis and considerable morphological abnormality. It seems impossible, therefore, to identify the mosaic disease of okra in Trinidad with that in India.

Summary

A description is given of mosaic diseases of seven species of Malvaceae and one species of Tiliaceae in Trinidad. Graft-transmission has shown the diseases to be caused in each case by a virus. In experiments with certain of the mosaics no transmission by sap-inoculation or through the seed occurred. There is evidence for the activity of an insect vector or vectors. No transmission occurred in any intergeneric or inter-family grafts, although some of them were very successful. Transmission took place in each combination between three species of *Sida*, the mosaics of which are therefore held to be due to a single virus. Symptoms on plants of *Sida* spp. in the field and the results from grafting experiments are compared with those from work in Brazil and certain differences noted. The mosaic disease of okra (*Hibiscus esculentus*) in Trinidad stands in marked contrast to a mosaic of okra

Table II

Comparison of relevant incubation periods with those quoted by Silberschmidt (1943)

Stocks	Scions	Incubation Period (Days)			
		Writer		Silberschmidt	
		Range	Mean	Range	Mean
Sida acuta	*Sida acuta* ...	15-25	(19.7)	14-113	(39.9)
,, ,, ...	*S. rhombifolia* ...	14-19	(15.3)	14-112	(52.5)
S. rhombifolia	*S. acuta* ...	14-24	(19.5)	10-110	(48.8)
,, ,, ...	*S. rhombifolia* ...	12-23	(16.9)	13- 83	(31.6)

described from India, and the former appears to have little economic importance. It is considered tentatively that *Abutilon* Virus 1 is responsible for the mosaics of *Sida* spp. in Trinidad.

The writer wishes to express his thanks to Prof. R. E. D. Baker and Mr. W. T. Dale of the Imperial College of Tropical Agriculture for assistance in many ways.

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MISCELLANEOUS NOTES

The Hot-water Treatment of Sugar Cane

During a period of five years tests were made in Louisiana to determine the effectiveness of the hot-water treatment on seed cane. Seed cane was submerged in hot water at a temperature of 52°C. for 20 minutes before planting. Replicated plots were planted with treated and untreated seed cane on nine plantations. Plantings were made in August, September, October and November.

The chlorotic streak virus in the stalks was completely destroyed or inactivated by the treatment.

The hot-water treatment stimulated the growth of buds and the young shoots. Better stands were obtained with the treated than with the untreated seed cane.

Significant differences in the sucrose content of the cane, in plots planted with treated and untreated seed cane, were not observed.

In the August plantings, the differences in yield between the plots planted with treated and untreated seed cane were small. In the September, October and November plantings, material increases in yield were obtained with several varieties in the plots planted with treated seed cane. With such varieties as C.P. 29/320 and C.P. 28/19, these increases were from 2.5 to 4.5 tons per acre of plant cane. Smaller, but significant increases were also obtained with stubble crops.

With a few varieties significant increases in yield were not obtained. With most varieties, it would appear that the profits to the planter would be increased by treating the seed cane.

(Summary of paper on "Response of Sugar-cane to the hot-water Treatment"—*Louisana Bulletin* No. 401.)

* * *

Effect of Cultural Practices on Citrus Rust Mite

In order to test the widely-held opinion that clean cultivation favours the citrus rust mite *Phyllocoptes oleivorus*, the size of the pest population on orange trees in clean cultivated and cover-crop plots was compared in St. Lucie County, Fla. The results showed that citrus rust mite infestations were not affected by cultural practice, but that the Florida red scale, *Chrysomphalus aonidum* was less abundant in cover-crop areas.—(Abstr. 1214 in *Hort. Abstr.*, **15** from *J. econ. Ent.*, 1944, **37** : 767-70)

The Editor is prepared to consider signed articles for publication in *Tropical Agriculture*. Such articles should normally vary between 1,000 to 6,000 words and may be illustrated if desired.

THE SUGAR INDUSTRY OF FIJI.—Continued

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Land Tenure *

Land held by the Company.—The Company owns approximately 67,000 acres of freehold land, of which 21,000 acres are considered suitable for the production of sugar-cane, and of which 19,000 acres are leased to growers. The Company also holds under various forms of leasehold from the Native Land Trust Board and from private owners, 81,000 acres of land, of which 29,000 acres are considered suitable for growing sugar-cane, and of which 2,700 acres have been sub-leased to growers. Thus, the total area of land under the control of the Company amounts to 148,000 acres of which 51,000 acres are cane land, and of which 45,000 acres are leased to growers.

Tenants of the Company.—A tenant of the Company is usually granted occupation of the farm for a period of 10 years (5 years in the case of a few of the farms in the Nausori mill area), subject to earlier termination by the Company in the event of legislation limiting its freedom of action in the matter of buying crops, etc., or on giving notice of its intention to cease purchasing cane in the district, and subject, where appropriate, to the Company obtaining renewal of its head lease (Clause 1). The tenant is prohibited from sub-letting or transferring the lease without permission in writing from the Company (Clause 3). The tenant is prohibited from giving any lien or encumbrance over crops, or any assignment of whatsoever nature and kind over crops, or the proceeds thereof, other than to the Company (Clause 6). The memorandum prescribes the division of the land between the various cane crops, requires the tenant to cultivate the land and tend the crops to the satisfaction of the Company and to apply artificial fertilizers as directed by the Company (Clauses 5, 6, 10, 11). The Company is entitled to terminate the tenancy if the tenant absents himself for two months in any one year (Clause 21). The tenant is not entitled to compensation for any improvement but is permitted to remove any buildings he had erected (Clause 17). An outgoing tenant is entitled to compensation for the value of standing crops on the farm, the amount being paid by the incoming tenant (Clause 4).

The tenant is not entitled to a renewal of his tenancy but renewals are invariably granted to satisfactory tenants. The Company refuses to permit the transfer of a farm except to a person approved by it, and has thereby prevented speculation in tenancies and crippling debt among its tenants. When a tenant dies and there is a near relative capable of carrying on the farm the Company gives this relative preference over other applicants for the farm. The sub-division of farms into holdings of uneconomic size has been prohibited. Strict control over cropping and methods of cultivation have prevented the exploitation of soil fertility ; in fact, the construction of sea walls and flood gates by the Company, and the application of mill mud, coral sand, and artificial fertilizers by the tenants, have greatly improved the fertility of large areas of land under the control of the Company. The inability of the tenant to use his farm or crops as security for loans has made the Company his principal source of credit and has restricted the opportunity for incurring heavy indebtedness. The Company has set an excellent example as a landord in respect of the management of land.

Contractors.—In addition to the land under the immediate control of the Company there is an area of 43,000 acres cultivated in sugar-cane by contractors. Contractors therefore account for 47 per cent. of the land under cane cultivation. Contractors hold land under several different forms of tenure. Some contractors own land, and others rent from private owners, but most of them hold "native leases" for periods ranging originally from 21 to 99 years.

The Company has endeavoured to encourage good farming practice and to prevent the abuse of land among contractors by clauses in the "Memorandum of Purchase of Cane". Thus, the Company prescribes the maximum area from which it will purchase cane in any one year (Clause 2), decides which varieties of cane are to be grown (Clause 4) and requires the contractor to tend and harvest the crops to its complete satisfaction (Clause 6). The Company has less authority over contractors than over tenants, and while many contractors are efficient and provident farmers, others pay inadequate attention to preserving the fertility of the soil.

The Native Leases Board, which advised the Governor in Council on the administration of native land from 1905 to 1940, could require a tenant to cultivate the land in a "good and husband-like manner", but lacked the staff necessary to enforce this condition. The tenant had no security of tenure beyond the original term of his lease, and renewals were subject to the same complicated procedure as the application for the original lease. Compensation

*The subject of land tenure in general is dealt with more fully in Report on agriculture policy for Figi and the Western Pacific High Commission Territories. Council Paper No. 24, Legislative Council, Fiji, 1944.

could be claimed in certain circumstances for the value of unexhausted improvements, and, in default of such payment, the lease could be extended by the Governor in Council. The general tendency has been for the tenant to extract the maximum possible from the land during the closing years of his lease. The Native Land Trust Board, which succeeded the Native Leases Board in 1940, has wide powers but at present lacks the staff and the capital essential for the proper management and development of land under its control.

Speculation in native leases has been the most wide-spread and important cause of improvident farming among contractors. There is keen competition for land suited to the production of sugar-cane. A lease of native land cannot be transferred without the consent of the Native Land Trust Board, but consent has been freely granted in the past. Evidence submitted to me in every mill area suggests that many contractors have incurred crippling obligations in the form of premia for the transfer of native leases. Premia ranged from £15 to £60 an acre for leases with from 4 to 18 years to run. In some instances there were growing crops and buildings on the land but it was affirmed that their value seldom represented more than a small fraction of the consideration paid. In other cases the land was in bush when taken over. In some of the cases which I have examined in detail, the premia have almost equalled the gross incomes which could be derived from the land by prudent methods of farming during the remainder of the lease. These cases may be exceptional but it seems clear that few contractors have any real conception of the financial burdens they so readily assume. The payment made by the incoming tenant may range from a mere token to payment in full. Interest is charged at rates generally ranging from 8 per cent. to 12 per cent. per annum on amounts outstanding. Much higher rates of interest were commonly charged before 1938, when the Money-lenders Ordinance (No. 14) made 12 per cent. per annum the maximum rate. Several farmers assert that they still pay rates of interest in excess of the legal maximum.

Large loans obtained for the payment of premia are usually secured by a crop lien, a bill of sale and a mortgage. These three documents are collateral. The Company pays the proceeds of the cane to the holder of the lien who is thereby afforded a convenient, and normally a secure, means of recovering the loan. The bill of sale transfers and assigns to the mortgagee the goods and chattels of the mortgagor. The mortgage transfers the title to the land from the mortgagor to the mortgagee. The mere cost of preparing and registering these documents is not inconsiderable.

The borrower is usually given a limited time, such as 3, 4 or 5 years, in which to liquidate his indebtedness, and he tends to overcrop the land in his efforts to clear himself of debt. In many cases the debtor finds his burden crippling, and, after a few years' struggle, he makes way for another contractor, having derived little reward from his exertions in the meantime.

Indebtedness and Credit

Indebtedness has reached alarming dimensions among many contractors. Crop liens deposited with the Company give an indication of this indebtedness among a section of the contractors (Table 4). The number of contractors involved rose from 1,020 in 1935 to 1,579 in 1941, but fell to 1,066 in 1943.* The amounts originally secured by these liens rose from £189,446 in 1935 to £364,019 in 1942, but was reduced to £301,509 in 1943. The amounts secured by liens in 1943 averaged £280 among those contractors involved. A large proportion of this indebtedness was incurred for the payment of premia on farms.

Table 4

Contractors' Liens

Year	No. of Liens	Amount Secured
		£
1935	1020	189,446
1936	1125	217,799
1937	1334	271,898
1938	1360	305,911
1939	1368	330,321
1940	1472	355,979
1941	1579	340,190
1942	1361	364,019
1943	1066	301,509

When a cane-grower takes over a farm on the Company's land the value of the standing crops is charged against him in the Company's books, but the proceeds of the crops enables him to pay off the amount owed. Thus, a tenant has no need to incur unproductive debt for the privilege of securing a farm. A tenant is prohibited from giving any lien or encumbrance over his crops except to the Company and he therefore has less opportunity than a contractor for borrowing a large amount of money.

Most cane-farmers, whether tenants or contractors, need credit for the purpose of carrying on the cultivation of their farms. A long interval of time elapses between the preparation of the land for planting and the completion of payment for cane. For example, farmers have received a large part of the payment for the 1943 crop but a further payment of about 3s. 6d. a ton of cane is still (August, 1944) expected. Preparation for planting some of the cane reaped in 1943 may have commenced early in 1941 and few farmers can finance themselves over such a long period without recourse to borrowing.

*An additional 2,912 contractors (in 1943) had given no lien, but many had incurred indebtedness on other forms of security.

The Company offers credit to both contractors and tenants on the security of the growing cane (Table 5). This financial assistance may take the form of hiring out heavy implements at a low charge, rent, coral sand, mill mud, artificial fertilizers and harvesting expenses, for which no interest is charged by the Company. Cash advances are made for living expenses, rent, livestock, implements, farm equipment, building materials, etc., on which interest at the low rate of 4 per cent. per annum is charged.

Table 5

Aggregate Advances to Farmers

Year	Tenants	Contractors
	£	£
1938	176,525	74,872
1942	130,387	48,793
1943	89,945	26,299
1944*	39,054	5,520

* January to June, 1944 only.

The amount which the Company is prepared to advance to a cane-farmer is determined primarily by the estimated value of his growing cane, and he is denied the opportunity of becoming indebted to the Company for an amount beyond his estimated capacity to repay. Many Indians seek to enhance their prestige by heavy expenditure on social and religious ceremonies. The cost of a marriage ceremony, for example, is determined more by ability to borrow than by a prudent consideration of what the family can afford. Indian families are usually large, and marriage takes place at an early age. Marriage and the procreation of a son is a religious duty to the Hindu and one with which economic considerations must not interfere. Abundant evidence was submitted to me during my tour of the sugar districts to prove that marriage and other ceremonies are an important cause of indebtedness among Indians in Fiji.

The amounts advanced by the Company in several recent years to tenants and contractors are shown in Table 5. Contractors and tenants are approximately equal in number but the aggregate advances to contractors are only a fraction of those to tenants, the difference being accounted for primarily by the fact that many contractors, having already pledged their crops to others, are ineligible for advances from the Company.

Many farmers are indebted to storekeepers for clothes and food, but such debts are normally liquidated or reduced each year when the farmer receives payment for his cane. Large numbers of promissory notes are outstanding among farmers.

There is little doubt that contractors, as a body, are much more heavily indebted than tenants. Few of the tenants interviewed owed more than £100, and the majority owed amounts ranging from £40 to £80. Some of the large contractors owe more than £1,000.

The income of the cane-farmer is usually received in two or three lump sums. Few farmers have facilities for the safe-keeping of this money and they are tempted to indulge in extravagant expenditure. A few years ago the Company endeavoured to promote thrift amongst its cane-farmers by offering to pay interest at the rate of 4 per cent. per annum on deposits, but the response has been poor.

The Company's Equipment

Capital Equipment.—The Company has invested large sums of money in the sugar industry of Fiji. Large areas of land had to be purchased or leased, and much of it had to be cleared of bush and forest, and then drained, before it could be brought into cultivation. Miles of sea-walls have been constructed to enable certain low-lying land to be used for sugar-cane. The Company originally confined its search for cane land to alluvial flats and, as the river valleys are strung out along the coast over long distances, unusally heavy expenditure has been incurred in the construction of tramways for the transportation of cane. Some of the cane crushed at Lautoka mill is grown 84 miles away on the banks of the Sigatoka river.* The Labasa mill also has a very extensive tramway system, much of which passes through areas producing no cane. Water, as well as rail, transport is used to feed the Nausori mill. Cane cultivation has since been extended from the flats to adjacent undulating areas, in the course of which the Company's scientific staff has evolved methods of utilising soils originally considered too poor for the production of sugar-cane. If the Company had possessed this knowledge at the outset it is probable that the areas supplying each mill would have been more compact, and the transportation system less extensive. The Company maintains in Fiji 400 miles of permanent tramway, 39 miles of horse-line, 164 miles of portable line, 44 steam locomotives, 15 internal combustion engines, 6,400 cane trucks and 1,300 other trucks and line vehicles, 14 launches, 15 lighters and 84 punts. The five mills of the Company have a capacity output of 171,000 tons of sugar in a 162 day crop.

Valuation of Fixed Assets.—The Company's assets were valued in 1941 by its own engineers on the basis of the cost of replacing the plant then in existence at costs obtaining in 1939, *i.e.*, pre-war. This computation was made for the purpose of insurance against war damage as Government was then considering a scheme of insurance. The total fixed assets, excluding land,

*The Company had planned, at one time, to erect a sugar mill near Sigatoka.

were valued at £4,874,000 in 1943. This total is made up of : mill plant and building, £1,894,000 ; transport plant, £2,804,000 ; other buildings £627,000 ; improvements. £257,000 ; and telephones, £12,000. It will be noted that the capital invested in transport plant exceeds that of the mills ; this is unusual, and is the result of the long distances over which cane is transported. In Trinidad, where the industry is of approximately the same size as in Fiji, the Companies' railway systems represent an investment, in round figures, of only £500,000, or little more than one-third the capital value of the mills. It must be noted, however, that in Trinidad the sugar Companies also make use of the Government railway system.

Repair and Maintenance.—Heavy expenditure has to be incurred every year for the repair and maintenance of equipment. Such expenditure is charged against operating expenses.

Depreciation and Obsolescence.—Many items of equipment, such as buildings, bridges, locomotives, heavy machinery and tramlines, are very durable and have long working lives, but they eventually wear out and have to be renewed or replaced. Funds must be available at the time renewals or replacements become necessary. Few replacements will be required during the first few years but eventually the time will arrive when extensive replacements are necessary. If, then, the cost of the replacements is charged to operating expenses, there will be some years in which little expenditure is incurred and others when heavy outlay is involved. Violent fluctuations would occur in costs of production, and adequate funds might not be available. It is therefore desirable and customary to make an annual appropriation to a depreciation fund calculated to provide a fund sufficient for all replacements as they become necessary. Some equipment may be rendered obsolete before it has come to the end of its working life by the invention of more efficient machinery. It is desirable that the Company should be in a position to take advantage of such opportunities for reducing operating costs. Floods and hurricanes occasionally necessitate exceptionally heavy expenditure on renewals and replacements. The Company considers that an amount equivalent to 4 per cent. of the replacement value of its fixed assets should be set aside annually in a replacement and depreciation fund. Subject to certain exceptions noted in the next paragraph, expenditure on renewals and replacement of buildings, machinery, locomotives, trucks, lines, etc., is charged to this replacement and depreciation fund.

Capital Expenditure.—When the capacity of a new piece of machinery exceeds that of the one replaced, a proportion of the cost, equivalent to the additional capacity, is charged to capital account. Similarly, when a new piece of equipment has the same capacity as the old, but exceeds it in efficiency and cost, the difference is charged to capital. When the Company's equipment is extended by such means as the construction of additional tramway, an increase in the number of locomotives and trucks, the building of additional houses, etc., the cost is charged to capital.

Working Capital.—Most of the sugar produced in Fiji is normally sold in Canada and the United Kingdom because they afford preferential treatment to Colonial sugar. A long interval of time occurs between the manufacture of sugar and the receipt of the proceeds. Some of the sugar produced in 1943, for example, has not yet (August, 1944) been paid for. During this interval the Company expends large sums of money on transporting sugar-cane, part-payments for cane supplied by farmers, and manufacturing, storing and shipping sugar. Some millers borrow from banks for such purposes and have to pay interest on their overdrafts. The Colonial Sugar Refining Company supplies its own working capital.

Stocks.—The important manufacturers of sugar machinery are located in the United Kingdom and the United States of America, and it is therefore necessary for the Company to maintain large stocks of spare parts in order that the process of manufacture may not be subjected to costly interruption. Large quantities of coal, sugar, bags, and other materials must also be kept in stock.

Total Capital.—The Company estimates the total capital it employs in the Fiji sugar industry at £5,775,000.

Price of Sugar-cane

The method of calculating the price of sugar-cane has been varied from time to time and a distinction is maintained between Nausori and the other four mills.

Original Basis.—Prior to 1923, growers were paid 10s. per ton for cane of "standard" quality, that is, 13.0 Pure Obtainable Cane Sugar (P.O.C.S.), with increases at the rate of 2s. 3d. for each degree above, and decreases at the rate of 1s. 8d. for each degree below, standard. Each grower's cane was sampled and analyzed separately, and the price varied according to the P.O.C.S.* The price of sugar-cane did not vary with the price of sugar, the object of the Company being to provide the growers with a stabilized

*The analysis of each individual's cane was made possible by the co-operative harvesting of cane, which enables the individual to deliver his cane in a few large consignments. This system of individual analysis would be impracticable in Trinidad where the delivery of cane by the individual farmer is spread over almost the entire crop season. Cane in Trinidad is delivered in animal drawn carts to weighing scales, and the queue at any one scale is normally composed of carts from many farmers. The cane is hoisted into railway trucks after weighing, and there it loses its identity with the farmer.

price. However, for a few years at the end of the last war, the price was supplemented by bonuses ranging in amount up to 10s. per ton of cane, and in 1920 a grant of £1 was made by the Company for each acre under sugar-cane.

1923-40.—In 1923 the Company added a bonus of 3s. 6d. per ton of cane, and undertook to continue this bonus so long as the Imperial Preference was mantained by the British Government. The method of calculating the price of cane remained unchanged in all other respects.

1940 *Agreement*.—In 1940 a new system of payment was introduced Under the old agreement the entire price was paid on delivery of the cane. Under the 1940 agreement the price is split up into several payments.

Lautoka, Rarawai, Penang and Labasa Mills.—At all mills except Nausori the Company pays a delivery price of 11s. per ton for Badila cane and 10s. per ton for all other varieties, together with the Imperial Preference bonus of 3s. 6d. per ton. Thus, assuming that Badila accounts for 50 per cent. of the cane, the delivery price would average 14s. per ton of cane.

The analysis of the P.O.C.S. of each individual farmer's cane was abandoned, and the mean P.O.C.S. of all canes supplied to the particular mill was substituted. This change was made at the request of the farmers who felt that those who were directed to harvest cane during the opening or closing weeks of crops, when the P.O.C.S. is normally low, were thereby penalized. This modification necessitated delay of the " scale " or sweetness payment until all cane had been crushed.

The principal change introduced in 1940 was the payment of a bonus of 1s. 3d. per ton of cane for each £1 by which the price of 94 net titre sugar (N.T.S.) exceeds £11. Prices payable under the old (1923-1939), and new (1940), agreements are shown in Table 6. Farmers obtain substantially higher prices under the new agreement when the value of sugar exceeds £11 per ton. For example, when sugar is worth £17 a ton, the farmer would receive 9s. 8d. a ton more for cane of 12 P.O.C.S., and 7s. 6d. more for cane of 14 P.O.C.S., under the new agreement than he would under the old agreement.

Nausori Mill.—The payment of cane delivered to the Nausori mill differs from the four other mills in that the " standard " quality of cane is taken to be 11 P.O.C.S., instead of 13 P.O.C.S., and the delivery price for Badila is 10s. instead of 11s., and for other varieties 9s. instead of 10s. per ton of cane. The reason for this difference in " standard " is not now traceable but it is known that climatic conditions at Nausori have an adverse effect on the sweetness of cane and it is presumed that the lower standard was adopted as an encouragement to growers. Hence, for cane of equal quality, higher prices are paid at Nausori than at other mills except when the average P.O.C.S. at Nausori is 11 or less. Table 7 shows the comparative prices per ton of cane payable under the 1940 agreement for various P.O.C.S., and for various values of sugar, at Nausori and other mills.

Cane Prices.—The prices paid for sugar-cane at the various mills in several recent years are shown in Table 8. The composition of the price of cane for one mill, Lautoka, is shown in Table 9.

Table 6

Prices of Sugar-Cane under Old and New Agreements

(Mills other than Nausori. Assuming 50 per cent. Badila)

F.O.B. Value of 94 NT Sugar	Price Per Ton of Cane							
	At 12 POCS (8.29 tons cane per ton 94 NTS)				At 14 POCS (7.10 tons cane per 94 NTS)			
	1923-39		1940 Agreement		1923-39		1940 Agreement	
£	s.	d.	s.	d.	s.	d.	s.	d.
9	11	10	14	0	14	9	14	9
10	11	10	14	0	14	9	14	9
11	11	10	14	0	14	9	14	9
12	11	10	15	3	14	9	16	0
13	11	10	16	6	14	9	17	3
14	11	10	17	9	14	9	18	6
15	11	10	19	0	14	9	19	9
16	11	10	20	3	14	9	21	0
17	11	10	21	6	14	9	22	3
18	11	10	22	9	14	9	23	6

Table 7

Comparison of Cane Prices at Nausori and other Mills

(1940 Agreement)

F.O.B. Value of 94 NTS	Price Per Ton of Cane											
	10 POCS or Lower		11 POCS		12 POCS		13 POCS		14POCS			
	Nausori	Other Mills	Nausori	Other Mills	Nausori	Other Mills	Nausori	Other Mills	Nausori	Other Mills		
£	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.		
9 ...	12 10	14 0	13 6	14 0	14 9	14 0	16 0	14 0	17 3	14 9		
10 ...	12 10	14 0	13 6	14 0	14 9	14 0	16 0	14 0	17 3	14 9		
11 ...	12 10	14 0	13 6	14 0	14 9	14 0	16 0	14 0	17 3	14 9		
12 ...	14 1	15 3	14 9	15 3	16 0	15 3	17 3	15 3	18 6	16 0		
13 ...	15 4	16 6	16 0	16 6	17 3	16 6	18 6	16 6	19 9	17 3		
14 ...	16 7	17 9	17 3	17 9	18 6	17 9	19 9	17 9	21 0	18 6		
15 ...	17 10	19 0	18 6	19 0	19 9	19 0	21 0	19 0	22 3	19 9		
16 ...	19 1	20 3	19 9	20 3	21 0	20 3	22 3	20 3	23 6	21 0		
17 ...	20 4	21 6	21 0	21 6	22 3	21 6	23 6	21 6	24 9	22 3		

Table 8

Cane Prices

Year	Price Per Ton of Sugar Cane				
	Nausori	Rarawai	Labasa	Lautoka	Penang
	s. d.	s. d.	s. d.	s. d.	s. d.
1938	14 1	15 1	13 2.31	14 10.56	15 9.93
1939	16 3	15 8.5	14 6.30	15 5.28	16 2.98
1940	18 11.19	20 1.125	19 10.08	20 4.65	20 6.01
1942	20 3.01	20 1.62	18 11.91	19 3.73	19 6.96
1943*...	22 11.75	22 11.37	23 6.04	22 5.75	23 3.07

* Sales of 1943 not yet completed. An additional payment of 3s. 6d. is assumed in this table, but the true amount may be slightly more or less.

Price of Sugar

The amount of the bonus payable for sugar-cane under the 1940 agreement (Clause 10B) varies with the price of sugar. The price of sugar per ton is calculated by adding together the (a) total local sales of sugar, (b) total value of export sugar f.o.b. Fiji, (c) total certificated preference, (d) total Canadian benefit pool, and dividing the sum of these four items by the number of tons of 94 net titre sugar produced by all mills.

Local Sales.—A small proportion of the total production of sugar is sold on the local market. In 1942, for example, local sales totalled 8,630 tons. Part of the local sales consists of sugar sold to employees of the Company and to farmers at rates lower than those in the local open market. Local selling prices per ton of sugar are, at present, £11 4s. to employees, £14 to farmers, £15 on the open market in 20 ton lots, £15 10s. on the open market in 5 ton lots, and £16 on the open market in 1 ton lots.

Table 9

Value of Fiji Sugar, 1930-40, 1942-43

(*f.o.b. Fiji, 94 N.T.S.*), *per ton*

Year	Value, Fiji, per ton		
	£	s.	d.
1930-34 (inclusive)	10	1	6
1935	10	0	6
1936	9	15	6
1937	10	10	10
1938	10	9	6
1939	12	14	10
1940	14	7	11
1942*	14	19	5
1943*	18	4	0

* 1942 and 1943 include some outstanding items which are estimated. Part of the rise in the value of sugar in 1943 was due to the smaller crop which increased the contribution of the Special Preference Certificate.

Export Sugar.—The basic price of export sugar is at present fixed by the Ministry of Food in Great Britain. This price includes the benefit arising from the Imperial Preference of £3 15s. sterling per ton of sugar.

Certificated Preference.—Great Britain grants Fiji Special Preference Certificates, on 55,000 tons of sugar, to a total value of £196,763. These certificates were first issued in 1934-35 to compensate for a reduction in the Imperial Preference from £4 15s. sterling, to £3 15s. sterling, a ton.

Canadian Benefit Pool.—The price paid by the Canadian Government for Empire sugar during the war includes an extra 7d. sterling per cwt., of which Fiji receives an agreed share through the Canadian Benefit Pool, based on the percentage of Empire sugar deliveries to Canada which she supplied during 1936, 1937 and 1938. The total value of this Canadian Benefit Pool to the Fiji sugar industry amounted to £19,201 in 1942.

The price of sugar, therefore, is composed not of one, but of several, items. Some persons assume that an increase in the basic price of export sugar by the Ministry of Food must lead automatically to an increase in the price of sugar-cane, but this is not invariably the case, for the total production of sugar is a factor which must be taken into consideration. In 1943, for example, the total output of sugar was only 56,410 tons, and the addition to the basic price of sugar arising from the Special Preference Certificates was £3 9s. 9d. per ton, *i.e.*, £196,763, representing the value of 55,000 certificates, divided by 56,410 tons of sugar. If the output of sugar rises to 140,000 tons the Special Preference Certificates will add only £1 8s. 1d. to the basic price per ton of sugar (i.e., £196,763 divided by 140,000). In such circumstances, an increase in the basic price of sugar by, say, £1 a ton, would be insufficient to counter-balance the decline of £2 1s. 8d. a ton in the value of the Special Preference Certificates, and the net result would be a fall instead of a rise in the total price per ton of sugar, and consequently of sugar-cane. Hence, the price of sugar-cane may fall even when the Ministry of Food increases the basic price of sugar. The farming community as a whole, of course, would receive very much more from the sale of, say, 1,000,000 tons of cane required to produce 140,000 tons of sugar, than it did for the 434,000 tons used in producing 56,000 tons of sugar in 1943. For example, in 1942 the price of cane averaged 18s. 9d. a ton; the farmers produced 1,024,221 tons of cane and received £959,714. For 1943, the final price of cane will be higher—probably about 22s. 7d. a ton, or 3s. 10d. a ton more than in 1942—but the farmers delivered only 434,168 tons and will therefore receive only £489,719, i.e., £469,995 less than in 1942.

Prices of Sugar.—The prices obtained for Fiji sugar from 1930 to 1943 are shown in Table 9. The price of sugar showed little variation before the war but has since undergone a substantial rise.

Income from Sugar-cane (Table 3)

1938.—In the last pre-war year, 7,824 tenants and contractors shared £711,936 from the sale of sugar-cane, an average of £91 per farmer. There were, in addition, 102 tenants, 717 contractors, and 5 who were both tenants and contractors, who sold no cane. Some tenants and contractors had only recently taken over their farms. Some contractors practise a different "rotation" to tenants, and consequently have no cane to reap during one year of the rotation. Many of the smaller farmers have additional sources of income and many of the larger farmers employ wage paid labourers.

1942.—In 1942 there were 7,572 farmers who shared £959,714 for the sale of cane, giving an average of £127 per farmer. The increase in income from cane in 1942, compared with 1938, was due primarily to the increase in the price of cane introduced by the 1940 agreement.

Conclusion

The decision of the Colonial Sugar Refining Company to convert its estates into small-holdings was an exceptionally bold one, and the Company deserves great credit for the skill and energy with which the transformation was effected. The success achieved by the Company in rapidly training thousands of Indian labourers to become cane-farmers on their own account is an achievement of outstanding merit. The cane-farmers are similarly entitled to praise for the manner in which they adapted themselves to changing circumstances and the ability with which they shouldered their new responsibilities. The cane farming industry was introduced into Trinidad towards the end of the 19th century for the same reason as in Fiji, namely, the difficulty of securing an adequate supply of wage-paid labour. The cane farming industry was encouraged in Trinidad largely because the Companies found that the farmers were willing to sell cane at a figure less than the cost of production on estates, but it was always considered essential for the Company to produce a large proportion (say, half) of the cane supplied to its factory in order to secure a sufficient total quantity and reasonably regular deliveries. The Colonial Sugar Refining Company has demonstrated that cane farmers can be so organised as to ensure regularity of delivery in normal circumstances, i.e., except when, as in 1943, the farmers refused to cut their cane. But there are indications in the British West Indies that the Companies, using scientific methods and with the aid of mechanical labour-saving devices, will be able to produce cane at a cost appreciably less than the price satisfactory to farmers. The mechanisation of the cane-growing industry in the British West Indies is still largely in an experimental stage—

except in so far as the preparation of the soil is concerned—and has not reached that advanced stage of Hawaii where the output of sugar per employee is probably 5 to 6 times that of the British West Indies. The peasant, throughout the world, is prepared to make some sacrifice in his standard of living for the freedom and liberty which he enjoys, but the disparity between his output and that of a highly mechanised industry such as in Hawaii is of such magnitude that it seems doubtful whether the small cane producer can survive.

Mr. O. T. FAULKNER, C.M.G., B.A., Dip. Agric.— AN APPRECIATION

Mr. O. T. Faulkner relinquished his duties as Principal of the College on 31st March of this year. Officially, however, his retirement from the post did not become effective until the end of August. He succeeded Sir Geoffrey Evans in November 1938 and had thus been with us for nearly eight years—eight of the most difficult years the College has ever experienced.

Mr. Faulkner was born in 1890 and educated at St. Albans' School. He was awarded the Hertfordshire County Agricultural Scholarship and a major scholarship at Caius College, Cambridge, which he entered in 1909. He graduated with first class honours in the Natural Science Tripos in 1911 and obtained the Diploma in agriculture in 1912.

Mr. Faulkner first saw service abroad as agriculturist and mycologist to the research branch of the Rubber Growers' Association at Petaling Estate, near Kuala Lumpur, Malaya. After working there for two years he was appointed to the Indian agricultural service as Deputy Director of Agriculture, Lyallpur, Punjab. In addition to his duties as Deputy Director, he acted most of the time he was in India as Professor of Agriculture at the Punjab Agricultural College.

In 1921, Mr. Faulkner was appointed Director of Agriculture, Nigeria. With his characteristic ability for discerning the main issue he soon realised that one of the major problems of departments of agriculture in tropical Africa is the maintenance of soil fertility. He planned a long term programme accordingly and pursued this relentlessly, never deviating from his main objective. With a clear and definite policy he had little difficulty in getting the full co-operation of his staff and in inspiring a team spirit which went a long way in overcoming difficulties. The results achieved were not, at first, spectacular but in the end the systems of peasant agriculture which he developed for Nigeria proved sound because they were based on solid and reliable evidence. In Nigeria Mr. Faulkner will chiefly be remembered for the introduction, during his long tenure of office, of a system of mixed farming in the Northern Provinces of the Colony which was perhaps his main achievement. He also evolved a system for maintaining soil fertility by means of green manuring which is suitable for a large area of the Southern Provinces. Thus, his regime contributed much to general progress in the development of West African agriculture. His outstanding services to Nigeria were recognised in 1928 by his being made C.M.G. In 1936, he was transferred to Malaya, where he spent nearly two years as Director of Agriculture, Straits Settlements and Federated Malay States, and Agricultural Adviser to the Malay States.

Soon after his arrival in Trinidad Mr. Faulkner, in consultation with the heads of the College departments, spent much time preparing evidence for submission to the West Indian Royal Commission which was due to arrive in Trinidad in February 1939. This provided an admirable opportunity for the new Principal to make himself thoroughly acquainted with all the activities of the College and with its problems. The result was a comprehensive research programme, portending expansion of the scope and activities of the College and covering research into crop and animal husbandry, peasant farming, soil erosion, the maintenance of soil fertility. marketing, agricultural indebtedness and credit, veterinary science, animal nutrition, plant breeding, sugar technology, food storage and plant diseases and pests. The Royal Commission later recommended the centralization of all major research and investigation at the College and the provision of funds by Parliament for continuing and extending this work for a definite term.

The outbreak of war put a stop to the implementation of all these plans, but not to the discussion of them. The perfection of policy against a time when more staff, equipment and funds should be available required endless conferences by the Principal with the authorities both at home and in the West Indies, and with visiting members of the Governing Body. Discussion continues; but whatever expansion of the College activities may finally result will be largely based on the proposals originally submitted by Mr. Faulkner. No one strove harder than he to prepare the ground and his greatest contribution to the College is the immense amount of work he did to ensure the soundness of the foundation of its future.

With a depleted staff long overdue for leave in a temperate climate and the difficult economic and social problems in Trinidad caused by war conditions, Mr. Faulkner was able to maintain all essential College services. Research, although slightly restricted, continued to progress and there was no interruption in the training of diploma and postgraduate students, which indeed increased in volume. In this period occurred the formation of the Staff Association, the revision of certain courses of instruction, a good deal of progress in cacao and banana researches and the creation of an animal nutrition unit. From the early days of the war, the College contributed in no small measure to the war effort and the Principal did his utmost to help and encourage the staff in their

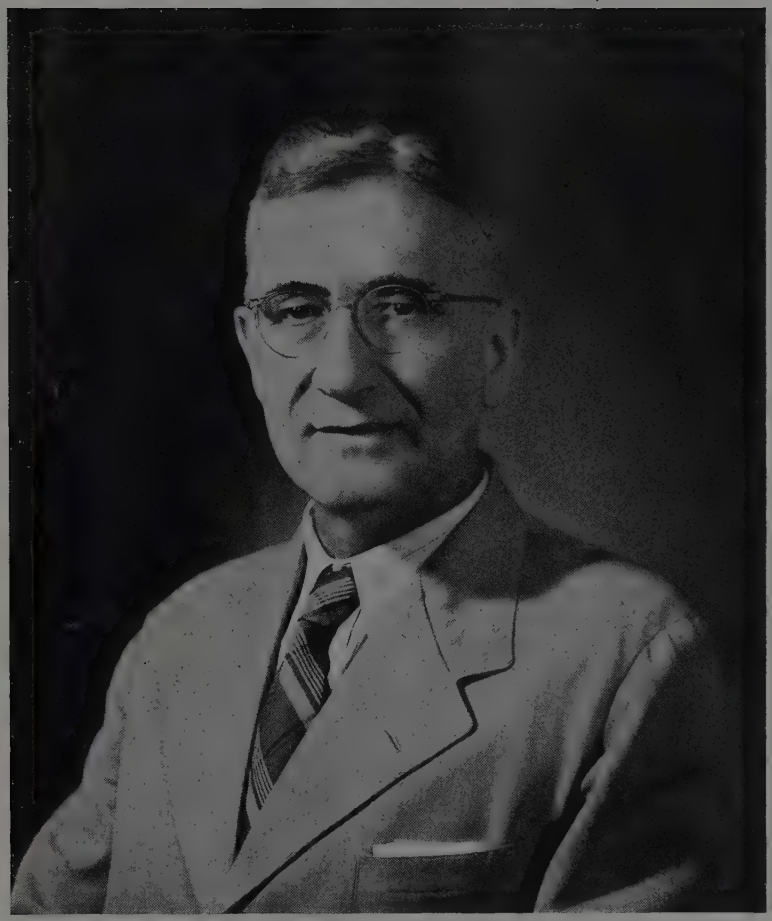

Photo by *Ace Studio*

MR. O. T. FAULKNER, C.M.G., B.A., Dip. Agric.

endeavours "to do their bit". Subscriptions were raised for the Trinidad Fighter and Bomber funds, and facilities were provided for training R.A.F. cadets. The College took its full share of voluntary war time work participating in the "grow more food campaign" and in the activities of the local branches of the British Red Cross, A.R.P., the W.V.S. and also of the volunteer Special Reserve Police Force. Several conferences were held of which the most successful were those attended by the sugar technologists from all parts of the Caribbean area. Mr. Faulkner represented the College on a number of Trinidad committees and boards and rendered particularly useful services to the Cacao Subsidy Board. He also did valuable work as Chairman of a Committee of Directors of Agriculture from the West Indian colonies to consider matters connected with food production and control. Even though they could little be spared from the College, he was instrumental in arranging several missions for senior members of the staff to different parts of the world, notably the Pacific and Central America. These missions not only were of considerable benefit to those who undertook them, but also helped to make the College known abroad and to establish invaluable research links with other scientific institutions.

Perhaps Mr. Faulkner's greatest qualities are his straightforwardness and his utter sincerity. He was a Principal of great determination and once his mind was fully made up on a certain line of action he would seldom deviate from it. He took infinite pains over his work and was never satisfied until he had thoroughly explored every aspect of a problem. He never sought popularity and always pursued the course which he considered right, irrespective of the consequences to himself. He was rather shy and retiring and disliked any kind of ostentation. His shyness may have created the impression on those who did not know him well that he was not approachable. Actually he was most approachable and always ready to give his advice freely to anyone in difficulty, and his wide experience of men and the world made him a reliable and wise counsellor. When occasions arose, he was generous to a degree. His cheerful and kindly personality was well liked and respected by the staff and students.

Mr. Faulkner found his happiness in simple pleasures and there was nothing he enjoyed more than a pipe and a good talk on his verandah. Before the war he played tennis and golf regularly but he eventually gave these games up to devote almost the whole of his spare time to his food garden. Mrs. Faulkner's charming personality was well matched with his. The Faulkners both enjoyed walking and golf and quite often their tall figures could be seen striding round the College golf course or off for a jaunt in the Northern hills. She threw herself wholeheartedly into the College war effort and as she was a fully qualified surgeon she was able to take a very active part in the work of the local British Red Cross. She was, moreover, an accomplished painter and became the first President of the Trinidad Art Society. Her oil and water colour paintings were much admired and many of them decorated and brightened the walls of the Principal's house. The Faulkners are both keen yachtsmen and the Principal, towards the end of his stay in Trinidad, spent much of his spare time over the plans for a new yacht which he intended to build on his return to England. The boat is now well on the way to completion and before long the Faulkners and their two boys will make it their permanent home. We extend to them all our best wishes for success and many happy days in their new craft.

PINEAPPLE PLANT SELECTION

According to an article published in the *Qd. agric. J., 61 : 203-15* the use of inferior plants as sources of planting material causes much loss to Queensland pineapple growers. This article explains what is meant by "inferior plants" and describes methods for reducing their numbers in the plantation. Inferior plants are of two classes (1) plants from normal stock which have developed some defect owing to poor growing conditions; (2) plants from inherently defective strains, and they and their progeny remain inferior regardless of what treatment they receive. Selection to eliminate inferior types will cause a rapid and lasting improvement. While it is necessary to cull out any defective strains, there are three inferior types that deserve particular attention: they are known as collar-of-slips, long Tom, and the dry-fruit strains. These are described and illustrated, with desirable fruits for comparison. In eliminating undesirable types the removal and discarding of slips from such plants before they are matured, or their rejection in any other way, will be fully effective only if the grower takes care not to use the crown, suckers, or butts from such plants. Selection of planting material is best practised on plant crops and preferably on the summer fruit crop, both because this yields the most planting material and because the normal summer fruit and plant type most closely approaches the normal.

* * *

ELECTRONICS APPLIED TO FOOD

It is stated that by using high frequency electricity for blanching vegetables in place of flowing steam or boiling water, food chemists at the New York State Agricultural Experiment Station at Geneva, N.Y., reduced the loss of Vitamin C in treated raw cabbage from the 30% to 40% occasioned by the usual blanching methods to only 3% by electronic blanching.

(*Hort. Abstr.*, 16, No. 2, p. 137.)

THE EARLY INTRODUCTION OF COCOA TO WEST AFRICA*

By F. N. Howes, D.Sc.

While going through old records at Kew, Dr. Howes discovered some papers which shed an interesting light on the earliest days of attempts to establish cacao on the West Coast.

The date of the first introduction of the cacao tree to the British West African possessions is somewhat uncertain. Most of what is known with any certainty on the subject has been recorded by other writers and ably summarized by van Hall in his well known and standard work on cocoa and cocoa cultivation.

The credit of having first brought the cacao tree from the New World to the African tropics undoubtedly goes to the Portuguese. They are reputed to have planted cacao on the island of San Thome (off French Gabon) as far back as 1822. It was not until about 1870, however, that cultivation was undertaken seriously there. By 1895, the export of cocoa beans from this island had reached a million kilograms, which was a considerable quantity for those days.

With regard to the Gold Coast, which has been for many years the leading cocoa producer of West Africa, it is stated that in 1868 the Basel Mission at Akropong (in Akwapim, Eastern Province) had a few cacao trees growing in their grounds and that these were flourishing. It is also stated that in 1879 a native of Mampong (also in Akwapim) brought back pods from Fernando Po (an island off the Cameroons) where he had been working, and raised a few trees which he planted on his farm near that village. These trees are believed to have been the parent trees of the Gold Coast industry. Cultivation on the Gold Coast was greatly encouraged by Sir William Griffith, who was Governor from 1880 to 1895, and who established the botanic garden and experiment station at Aburi 1892—where the writer happened to be stationed as an agricultural officer at one time, and where cacao plots were a special feature.

The fact that the Gold Coast industry developed from this single introduction (or possibly two introductions) is considered to be the reason for the remarkable uniformity of Gold Coast cacao compared with that in many of the older cacao growing countries. This uniformity is now of special interest in connection with the study of local cacao diseases and the resistance of cacao to disease.

In Nigeria, the position is very similar to that of the Gold Coast. For cocoa is alleged to have been first introduced there by a native chief called "Squiss Banego" in 1874—also from Fernando Po. He established a cocoa farm in the Bonny district and cultivation spread. By 1887-9 a few plantations had been established by European companies, those of the Royal Niger Company at Abutshi and Onitsha being taken over by the Government of South Nigeria in 1900.

It is thus apparent that the cacao of both the Gold Coast and Nigeria was derived from a common source—Fernando Po. From which part of the American tropics the Portuguese obtained their seed or plants in the early part of last century there appears to be no record, but it is probable that they would have come from Para or other parts of Brazil.

In Sierra Leone the cacao in cultivation is conceded to be of a different type from that in general cultivation in the Gold Coast and Nigeria. This raises the question of the origin of Sierra Leone cacao. In this connection it may be of interest to note that among old records at Kew is one of young cacao plants being sent to Glasgow Botanic Garden for shipment to West Africa on the 30th August, 1864. Unfortunately, there are no details as to the ultimate destination of the plants and how they fared. However, it is probable that at this early period they would have been consigned to Freetown and not to any other part of West Africa. As the voyage is a comparatively short one it is quite probable the plants survived and ultimately became established in Sierra Leone. At about this time, economic plants of various kinds, including cacao, were constantly sent from Kew to such far off places as the botanic gardens at Brisbane and at Durban and usually survived the long voyage. There was free intercourse and exchange of plants between Kew and the West Indies at this period and the probability is that the cacao plants despatched from Kew in 1864 were raised from West Indian seed and were not of Brazilian origin as is believed to be the case with the early introductions to the Gold Coast and Nigeria.

There is thus the interesting probability that the present day cocoa of West Africa (apart from recent introductions at experiment stations) is of dual origin, that of the Gold Coast and Nigeria having originated from Brazil and that of Sierra Leone from the West Indies.

* *Reprinted from "African Affairs," July 1946*

TAMARIND SEED PECTIN

It has been found that if, instead of using the seed flour as the starting material, pounded seeds (size of a sweet pea) are taken for extraction, most of the proteins and fibres remain with the swollen seeds and the pectinous matter passes into solution, giving a purer material. The aqueous solution of the pure material is dextrorotatory and does not reduce Fehling solution. It has a very low acid number. In its colour reaction with iodine the substance differs considerably from starch. Tamarind seed pectin seems to resemble seed-pectins more than fruit-pectins.

(*Hort. Abst.*, 16, No. 2, p. 140.)

REVIEW

CROP PRODUCTION AND ENVIRONMENT

BY

R. O. WHYTE.

Pp. 372. (Faber and Faber, 1946) 25s. net

"Seed time and harvest time shall not fail" and the surety with which these processes have followed one on the other has perhaps tended to hide the fact that the succession is by no means inevitable. It is now realised that the plant passes through several stages during its development, and that growth and development are *not* synonymous terms. It has been found that the developmental stages are controlled by external environmental factors, and it should be possible to isolate these factors and then to expose plants to optimal doses of them under artificial experimental conditions, thus controlling growth and development at will.

This branch of developmental physiology is comparatively new, but has already made much progress since it was initiated by Klebs in 1918. Klebs believed that flowering was caused by changes in the composition of the plant. Garner & Allard showed that the photo period had a pronounced effect in many cases. Then Lyssenko and his co-workers put forward the idea of irreversible phasic development, each phase depending for its completion on a definite set of environmental conditions. English workers have now shown that the postulated irreversibility of phases is not correct.

It is disturbing to find that "Tropical and Sub-tropical Crops" can be dealt with in nine pages out of a total of 335, and moreover that almost all of these few pages are devoted to reports from the Benares Hindu University. It is true that records of growth and development of tropical crops are both scanty and scattered, but they do exist. Mason's work on Growth and Correlation in the Oil Palm—(now some twenty years old) — where it is reported that the oil palm is photoperiodic — deserves mention. Many plants in the tropics are photoperiodic even though the seasonal variation between night and day may be very small — certainly under an hour. Thus mangoes here in Trinidad flower about the equinoxes, and old, well established trees may have two crops per annum, one in the Summer (the main crop) and the other at Christmas. Certain cottons are photoperiodic, e.g. the Marie Galante of the West Indies. This is a short day cotton, but if fruiting is prevented by picking off the young bolls, flowering will continue into the long days, in a period of the year when plants will not normally flower. Sea Island Cotton is not photoperiodic, but flowers only after it has reached a certain stage of nodal development, irrespective of the actual size of the internodes. Moreover, the plant may revert to vegetative growth from the reproductive phase under certain environmental conditions, such as dull, overcast weather. Again, if vigorously growing fruiting plants are 'topped,' they may revert to the vegetative phase again for a period.

In spite of the very brief attention paid to the tropical crops, the book can be confidently recommended to all those who are interested in the growing of crops in the tropics. Many of the factors discussed in the book are much more obvious in temperate climates than in the tropics, e.g., photoperiodism, but this does not mean that factors which operate in temperate climates do not also operate in the tropics. Went has recently shown that tomatoes require an appreciable day-night temperature variation for fruit setting. In Trinidad, little difficulty is encountered in growing tomatoes in the early part of the year, when the nights are cool, but there is considerable difficulty in getting them to grow in the wet weather when the nights are not so cool. Hitherto this has been ascribed to pollination difficulties in the wet season, but it may be that thermoperiodism (or lack of it) is the more probable explanation. It will be of interest to see how the newly developed hormonal treatments for inducing fruiting will react in this instance.

E. P.

COFFEE PULP AS ORGANIC MANURE

Preparation and Utilization of Coffee Pulp as Organic Manure

The improvement of the soil of Puerto Rico by continued cultivation and by erosion makes necessary the use of organic manures. The value of coffee pulp for this purpose is emphasized. The pulp forms about 70% of the coffee berry and is rich in nutritive substances. Analyses of the fresh pulp and of its ash show that employing the pulp as manure will result in returning to the soil about a quarter of the phosphoric acid, half of the potash and a litle more than a quarter of the nitrogen that the coffee trees need for ripening their berries. The pulp and the parchment resulting from the separation of the beans from the berries should not be used fresh or incompletely fermented. Two types of fermenting pits are described and figured. The best period for applying the fermented pulp to the soil is during May and June when rain is abundant.

(*Rev. Agric. Puerto Rico,* 35 : 140-3. *Hort. Abstracts* 16, 130 : 1946.)

CHEMICAL NOTES

(Compiled by the College Department of Chemistry and Soil Science)

Direct Consumption Sugar from Raw Cane Juice by the use of Base-exchange Resins*

DURING the 1944 sugar-cane season, an experimental pilot plant was operated in the Audubon Sugar Factory for the purification of sugar-cane juices by a recently-developed process incorporating ion-exchange resins. The method of purifying the sugar-cane juices by the application of ion-exchange treatment is a radical departure from methods heretofore used.

It is generally known that ion-exchange treatment removes minerals from water solution, and is usually considered a demineralization process. When sugar-cane juices are de-ionized by this new process, non-sugar solids other than minerals are also removed and there resulted highly purified sugar solution consisting principally of sucrose, dextrose, and levulose. The elimination of non-sugars from juices results in sirups substantially higher in purity than those obtained by standard sugar-house practice or by ealier methods of ion-exchange treatment. When these sirups are exhausted by crystallization of sucrose to the same degree common to present sugar manufacturing practices, an increased yield of sugar results.

One of the outstanding features of the process is that the ion-exchange treatment is not superimposed upon the usual methods of defecation. It is in itself a process for the production of juice from which high purity direct consumption sugars and high grade edible molasses can be obtained.

The following data is indicative of the products obtained by means of this new ion-exchange process.

Typical Analyses of Ion-exchange

	Raw juice	*Ion-Exchange treated juice*	*Final Molasses*
Purity (Clerget) % Sucrose ...	76.75	88.4	39.01
Invert % ...	8.44	9.9	49.6
Non-Sugar Solids %	14.81	1.7	11.4
Ash %	3.14	0.064	0.8

Purity by direct polarization is 26.7 %.

It is well known that the cane varieties grown for the production of sugar on the heavy dark soils of Louisiana produce sirups of darker color and stronger flavor than in other localities where sirup is produced from selected cane varieties grown on light sandy soils. Sugar-cane juices treated by ion-exchange are purified to the extent that they may be made into light-coloured mildly-flavored sirups suitable for table use directly or for blending with the more strongly flavoured sirups normally produced in Louisiana. By this method it is possible to produce a standardized uniformly high quality sirup.

The quality of the products produced, as well as the adaptability of the process to Louisiana conditions was decidedly favourable, and it is planned to undertake industrial exploitation in the immediate future.

* Abstracted from an article by W. A. Blann in *The Sugar Bulletin*, Vol. 23. p. 198, 1945.

* * *

Cultural Functions of the Plough and Hoe

Experiments on a heavy loam at Rothamsted with mouldboard ploughs, cultivators and rotary cultivators have shown that crop yields are independent of the cultivation treatment provided the land is free from weeds. The plough gave a cleaner seedbed than did the other implements and higher yields were obtained by its use. The mouldboard plough, owing to its efficient control of weeds, is the most suitable cultivator for the English climate. The production of a clean seedbed is a more important function of cultivation than the production of a good tilth. It has similarly been shown that the main advantage of deep ploughing is that it gives a cleaner seedbed than shallow ploughing, though this is not necessarily true for all conditions,—*e.g.* when the deep ploughing breaks up a subsoil pan. There is no evidence, however, that in this respect deep ploughing has any advantage over shallow ploughing and running a subsoiler behind the plough—a method which is more economical of energy. Deep ploughing also affords a convenient means of incorporating fertilizers into the subsoil.

American experiments on maize and American and English experiments on potatoes, sugar beet and market-garden crops have established that the benefits of hoeing are derived from its weed-killing function. It is concluded that if the new selective weed-killing dusts and sprays become commonly used in agriculture they will cause a revolution in cultivation technique; the only purpose of cultivation will then be the preparation of a seedbed.—(*Soils and Fertilizers*, **8**, 232, 1945).

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Manurial and Cultural Trials on Citronella

Manurial and cultural trials on citronella carried out in Ceylon have confirmed that (1) yields are very appreciably increased by manuring with a general mixture, (2) phosphoric acid and potash are the dominant fertilizer requirements of the crop, (3) the quality of the soil is not affected by manuring, (4) shade tends to reduce yields, (5) an interval of 3-4 months is the optimum period for cutting the grass. —(*Rept. of Dir. of Agr.* Ceylon, 1943).